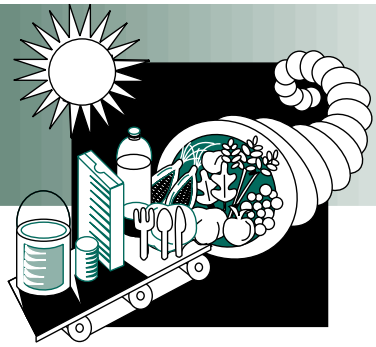
AGRICULTURE

Project Fact Sheet



New Enzymes For Corn Syrup Processing

Benefits

- A shorter, more energy-efficent process for producing HFCS
- A more active biocatalyst with greater thermal stability
- A more productive and less expensive HFCS process with greater flexibility for feedstock quality and processing conditions
- Potential 2020 target market is 17 billion pounds of HFCS per year
- Projected 2020 fossil fuel displacement is 17.4 trillion Btu

Applications

CLEC structured enzymes are currently used to manufacture a number of pharmaceutical products. The successful completion of this project will enable sweetener manufacturers to improve productivity and reduce energy use. This technology can be extended in the future to enable the efficient production of chemicals and materials from renewable biobased resources.

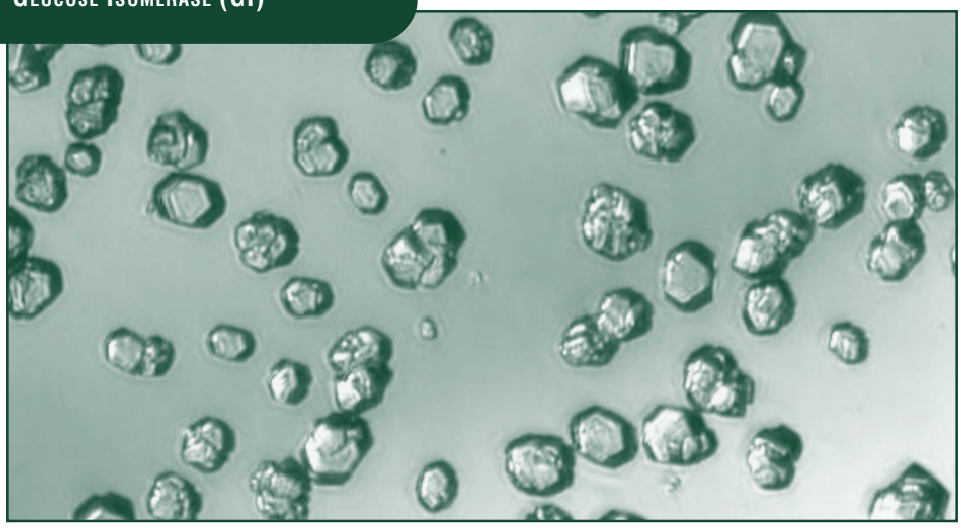
New processing method will give U.S. producers a competitive edge in world markets

High fructose corn syrup (HFCS), a primary sweetening agent, is currently produced in a long, multistep process under highly exacting processing conditions. To obtain commodity scale quantities of a fructose-rich (55 percent) corn syrup mixture, which has a sweetness equivalent to sucrose, manufacturers must recycle the glucose-rich stream from an ion exchange separation step many times. This entire process requires that the active enzyme (glucose isomerase, or GI) be immobilized and that the process be conducted under precise temperature and pH conditions.

This project will explore the potential for using a crystalline cross-linked enzyme, CLEC® to directly convert the natural glucose/fructose corn syrup mixture to the high fructose levels required by food manufacturers. CLEC®, a more stable form of GI, should allow the production process to be conducted at higher temperatures and, in turn, eliminate the energy intensive fractionation and evaporation steps. In addition, its enhanced organic resistance over standard GI should result in extended enzymatic activity and enable the use of a less costly glucose feedstock.

The successful application of the current CLEC® technology to the HFCS production process can lead to new uses for stabilized biocatalysts in the production of many products from renewable biobased products.

Glucose Isomerase (GI)



Thermostable GI CLEC® will enable more energy-efficient processing of corn syrup.

Project Description

Goal: To develop a stable cross-linked crystalline CLEC® enzyme form of glucose isomerase (GI). The additional thermostability of the CLEC® form of the GI should enable a more direct conversion of glucose to fructose syrup and eliminate the chromatography and water evaporation steps from HFCS processing.

This research will be conducted as a team effort. The enzyme will be produced using Genencor's current glucose isomerase protein and Altus' CLEC® technology. ORNL will provide bioprocess engineering and testing expertise, and Cargill, Inc., will conduct technical and economic assessments of HFCS process improvements.

In Year 1, conditions will be developed to produce optimal cross-linking of GI in CLEC® form and to integrate it with the HFCS process. Such parameters as the extent of cross-linking and the pH during cross-linking will be varied to produce multiple crystal forms and identify the best conditions for an active, stable biocatalyst. When key protocols are known, the CLEC® prototype will be scaled up to produce enough product to test in columns. In Year 2, the GI CLEC® will be scaled up to the 100-g scale and tested in extreme environments, and crystallization and cross-linking will be optimized. Economic evaluations will be conducted as CLEC® GI is tested in columns.

Progress and Milestones

Altus Biologics, Inc. has developed the CLEC® technology that locks the enzyme in active conformation and allows a higher degree of chemical modification of the enzyme without loss of catalytic function.

The following tasks and milestones will be accomplished using the GI CLEC®:

- The temperature at which glucose isomerase operates will be extended from the current 60°C to 90°C.
- The fructose content of the product (HFCS) will be increased from 42 percent to 55 percent.
- Direct production of 55 percent fructose will occur during isomerization, and the fractionation process will be eliminated.
- The cross-linked crystalline matrix will allow configuration of highly active glucose isomerase columns that can withstand high flow rates.
- The volumetric activity of the CLEC® form of GI will be 10 to 25 times greater than that of immobilized GI.
- Pilot studies will be conducted by the end of Year 2.

Project Partners

Altus Biologics, Inc.
Cambridge, MA

Cargill, Inc.
Dayton, OH

Genencor International, Inc.
Rochester, NY

Oak Ridge National Laboratory (ORNL)
Bioprocessing Research and
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